Remarks

Thorough examination by the Examiner is noted and appreciated.

Support for the amended claims are found in the original claims and the Specification. No new matter has been added.

Claim Rejections under 35 USC 112

Claims 12 and 26 have been amended to overcome Examiners rejection under 35 USC 112, second paragraph.

Claim Rejections under 35 USC 102(e)

Claims 1, 3, 5-13, 20, 21, 22, 24-26, 31-33, and 35 stand rejected under 35 USC 102(e) as being anticipated by Ohuchi (U.S. 6576562).

Ohuchi discloses a method for forming an etched opening in a substrate using a mask material including a carbon content of 80% or more (see Abstract). The relevant portions of Ohuchi (disclosing b-layer process) are included In Figures 7A through 7F (sixth embodiment with bi-layer photoresist, at columns 29-31), Ohuchi discloses and teaches a method for forming an etched opening e.g., a dual damascene using a bi-layer methodology with the upper layer being a silicon containing resist layer.

Ohuchi critically teaches the use of a lower organic layer film has a carbon content of greater than about 80% to provide an increased etching resistance (e.g., col 24, lines 11-54, col 29, lines 33-34), not disclosed to be a photoresist, and an upper photoresist film including a metal or semiconductor component disclosed to be silicon, aluminum, titanium, tungsten, and germanium (col 29, lines 44-45). Ohuchi does not teach or

disclose the elements of Applicants claimed invention including:

"providing an unpatterned non-silicon containing photoresist layer over a substrate to form a first resist layer;"

Nowhere does Ohuchi disclose that the lower layer in the bi-layer embodiment is a photoresist (see col 29 beginning at 13 to col 31). Ohuchi critically teaches the use of a lower **organic** layer film (in contrast with Applicants first resist layer) that has an **aromatic ring** and **carbon content** of **80 wt%** or more, preferably more than 90 wt% (see col 29, lines 31-35) to provide a high etching resistance. Applicants, by contrast claim a first photoresist layer. Ohuchi teaches that a conventional photoresist layer has a carbon content of about 70 wt % (col 30, lines 38-39). Thus, the teachings of Ohuchi, in this respect alone, are insufficient to anticipate Applicants disclosed and claimed invention; rather, the disclosure of Ohuchi directly teaches away from Applicants disclosed and claimed invention by teaching using an aromatic ring containing **organic layer** with a carbon content of greater than about 80 %.

Further, nowhere does Ohuchi disclose or teach:

"providing a silicon containing photoresist layer **on** the first resist layer to form a second resist layer **thinner** than the first resist layer".

Significantly, Ohuchi does not disclose any particular thicknesses of the first resist or the silicon containing second resist layer for forming a damascene opening as shown in Figures 7A-7F in the bi-layer embodiment, discussed in columns 29 to 31, which is the relevant portion applicable to Applicants disclosed and claimed invention.

Examiner contends that the above is "incorrect" and points to disclosure in an unrelated 3-layer embodiment where a lower layer is the organic mask layer, a mainly silicon containing layer (e.g., silicon oxide) is an intermediate layer (see col 25 lines 18-24, lines 36-43). Thus, in this embodiment, the specific disclosed thicknesses of the lower organic mask film and the uppermost conventional photoresist **overlying the silicon oxide film** are disclosed to have the **upper** conventional photoresist **thinner** than the organic film mask. The 3-layer embodiment of Ohuchi is a completely different structure and process (as is Ohuchi's 2-layer embodiment) than Applicants disclosed and claimed invention, where Ohuchi using two separate etching steps with different etching chemistries to first etch through the silicon oxide layer and then through organic mask layer (see e.g., col 26, lines 8-32). Moreover, the photoresist layer is disclosed to disappear during the intermediate (silicon oxide) layer etching process, and the intermediate layer film is disclosed to disappear during the dielectric layer etching process.

Examiner also points to an unrelated fourth embodiment which is disclosed for use in etching silicon nitride and polysilicon to form unrelated semiconductor features (e.g., at col 21), also working by an entirely different structure and principal of operation than Applicants disclosed and claimed invention.

Even assuming that the unrelated embodiments may be looked to for teachings with respect relevant to the bi-layer embodiment, Ohuchi generally teaches that the thickness of the photoresist film is **not restricted** but may include a wide range of thicknesses (col 15, lines 25-38), as may the organic mask

layer (col 13, lines 63-67). For example, in etching a gate structure (1st through 5th embodiments, columns 1-22), Ohuchi discloses that the lower organic layer is from 20 nm to 5,000 nm (col 3, lines 47-48), while the uppermost resist layer is from 5 nm to 10,000 nm (col 15, lines 30-32), thereby implicitly teaching at the upper range that **the upper resist layer is thicker than the lower resist layer**, clearly teaching away from Applicants disclosed and claimed invention, and certainly not anticipating it.

Thus, Ohuchi neither discloses nor teaches Applicants disclosed and claimed invention of a lower non-silicon containing photoresist layer with a **thinner** upper silicon containing photoresist formed **on** the lower non-silicon containing photoresist layer.

Ohuchi further does not disclose the following elements of Applicants disclosed and claimed invention:

"dry developing said first resist layer portions according to the second resist layer pattern to reveal the substrate according to a first plasma etching process **consisting essentially of nitrogen, oxygen, and argon** to form an etching mask;

plasma etching according to a second plasma etching process an opening into the substrate according to the etching mask; and,

then carrying out an in-situ ashing process to remove remaining overlying resist layers selected from the group consisting of the first and second resist layers."

Ohuchi nowhere suggests or teaches the use of a third etching gas, including argon for use in a dry development process as Applicants have disclosed and claimed, but rather repeatedly

refers to a **mixture of nitrogen and oxygen** for etching the high carbon weight organic mask layer (see e.g., col 29, lines 63-65). Ohuchi only discloses the use of argon (CF_4, O_2, and Ar) for etching the intermediate silicon oxide film in the tri-layer embodiment (col 26, lines 15-19) and for etching the dielectric insulating layer (col 26, lines 50-56). Moreover, Applicants make clear that the addition of Argon is preferred to provide optimal dry development of the first resist layer (see e.g., paragraph 0040 Applicants Specification). Ohuchi clearly fails to anticipate this aspect of Applicants disclosed and claimed invention.

Further nowhere does Ohuchi disclose or suggest **separate** in-situ ashing processes or **separate** simultaneous ashing and cleaning processes as Applicants have disclosed and claimed (e.g., claims 1, 12, 13, 25, 32, 33, 35). In contrast, in the bi-layer embodiment of Ohuchi, Ohuchi teaches that the organic layer (lower layer) and the silicon containing photoresist layer (upper layer) maintain a constant thickness and are **left in place** following etching of a via opening in the dielectric layer. Alternatively in the unrelated tri-layer embodiment, Ohuchi teaches that the upper resist layer **disappears during dry developing** of the lower organic mask layer (col 26, lines 34-39), and the organic mask layer disappears during etching of the opening in the dielectric insulating layer to stop on a barrier film (ethc stop layer).

Thus, rather than disclosing an in-situ ashing process **following etching an opening** to remove the first or first and second resist layers as Applicants have claimed, Ohuchi directly teaches away therefrom, either teaching simultaneous removal during dry development and etching processes in the tri-layer

embodiment, or teaching leaving the resist layers in place following etching of the via opening to become part of the multi-layer structure in the bi-layer embodiment (col 30, lines 55-65). Thus Ohuchi, in this respect as well, clearly fails to anticipate Applicants disclosed and claimed invention.

Applicants have previously addressed Examiners rejections of the remaining claims, and hereby incorporates by reference those comments herein. Ohuchi is clearly insufficient to anticipate Applicants disclosed and claimed invention.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

"The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Claim Rejections under 35 USC 103(a)

1. Claim 22 stands rejected under 35 USC 103(a) as being unpatentable over Ohuchi as applied to claim 1, above, and further in view of Smith (US 6,388,226).

The comments made above with respect to Ohuchi are reiterated. The limitations of claim 22 are now included in claims 1 and 25.

Smith discloses an improved low-field **toroidal plasma source** (see Abstract). Smith discloses that the plasma source can be operated to increase the etch rate of organic materials (see Abstract). Smith generally discloses that oxygen is useful for removing **photoresist in an etching process** (col 1, lines 60-65)

and generally discloses that adding a noble gas such as argon to a plasma can increase the output of active species (col 15, lines 29-43), for example in a nitrogen/oxygen plasma. Smith does not teach using a nitrogen/oxygen plasma **to dry develop a photoresist** layer or disclose a bi-layer or multi-layer resist or a method for developing or etching the resist.

There is no apparent motivation to combine the teachings of Smith with Ohuchi. Ohuchi nowhere suggests or teaches the use of a third etching gas but rather repeatedly refers to a **mixture of nitrogen and oxygen** for etching the high carbon weight organic mask layer (see e.g., col 29, lines 63-65). Even assuming arguendo proper motive for combination, such combination does not produce Applicants disclosed and claimed invention. For example, Applicants first photoresist layer is not the same material as the material of Ohuchi, nor does Smith suggest or disclose a dry developing process including an underlying resist mask layer (first resist layer).

Moreover, Smith discloses that argon increases the removal rate of photoresist (col 15, lines 53-55), thereby being inconsistent with Ohuchi's disclosed embodiment of **leaving the bi-layer in place**, thereby changing the principal of operation and making unworkable the method of Ohuchi.

"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention." *W.L. Gore & Associates, Inc., Garlock, Inc., 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).*

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious." *In re Ratti, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).*

2. Claims 23, 30, and 34 stand rejected under 35 USC 103(a) as being unpatentable over Ohuchi as applied to claim 1, 25, or 32 above, and further in view of Lee (US 6,569,599).

In the background of the invention, Lee discusses a bi-layer lithographic process including a lower photoresist layer and a silicon containing upper layer. Applicants note that the existence of bi-layer processes in the prior art is disclosed by Applicants, similar to the teachings of Lee, in Applicants discussion of the prior art and the problems presented in the prior art. Lee discloses that the lower layer may be an I-line photoresist. Applicants also note that Lee, teaches away from the use of acrylic polymers (col 1, lines 14-21). Significantly, Lee dose not disclose the relative thicknesses of the bi-layer resist and teaches the use a dry development process (O_2 plasma etching chemistry) different from both Applicants and Ohuchi, thereby teaching away from Applicants claimed invention as well as that of Ohuchi. Lee also does not disclose ashing or cleaning processes as Applicants have disclosed and claimed.

As such, there is no apparent motivation for combining Ohuchi and Lee since the method of Ohuchi specifically teaches away from using a conventional photoresist as a lower layer ((col 30, lines 35-40; col 31, lines 8-12) in the method of Lee (and Applicants), while Lee specifically teaches away from Ohuchi's (and Applicants) dry development chemistry, thereby changing the principal of operation of the method of Ohuchi, including the benefits of using of a high carbon content lower organic layer,

Nevertheless, even assuming *arguendo* proper motive for the combination of Ohuchi and Lee, such combination does not produce Applicants claimed invention for reasons previously outlined. "[A] patentable invention may lie in the discovery of the source of a problem

even though the remedy may be obvious once the source of the problem is identified. This is part of the 'subject matter as a whole' which should always be considered in determining the obviousness of an invention under 35 U.S.C. § 103." *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 243 (CCPA 1969).

"The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

"The fact that references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references." *Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993).*

3. Claims 36-38 stand rejected under 35 USC 103(a) as being unpatentable over Ohuchi as applied to claim 1, 25, or 32 above, and further in view of Moise (US 6,211,035).

Moise discloses "A via etch to contact a capacitor with ferroelectric between electrodes together with dielectric on an insulating diffusion barrier includes two-step etch with F-based dielectric etch and Cl- and F-based barrier etch."

Applicants respectfully suggest Moise is non-analagous art. Nevertheless, assuming arguendo, Moise is proper cited prior art, the fact that Moise discloses that a dual RF power supply is useful to improve selectivity and an etch profile in an unrelated etching process using unrelated (and corrosive (e.g., Cl)) etch chemistries for etching metal electrodes does not help Examiner in making out a *prima facie* case of obviousness. Applicants respectfully suggest that Examiner is clearly in error in making

the assertion that Moise uses "the same or similar gases and plasma conditions".

Since Examiner has not made out a *prima facie* case of obviousness with respect to Applicants disclosed and claimed independent claims neither has a *prima facie* case of obviousness been made out with respect to Applicant's dependent claims.

Finally, the applied prior art of record either individually, or in combination, fails to recognize or suggest a solution to the problem that Applicants have recognized and solved by their claimed invention:

"A method for etching an opening using a bi-layer photoresist to improve an etching resolution and reduce particulate contamination"

The Claims have been amended to clarify Applicants claimed invention in response to Examiners argument/comments and to distinguish over the prior art. A favorable consideration of Applicants' claims is respectfully requested. Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited. In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

Randy W. Tung (31,311)